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SOLID STATE ULTRAVIOLET PHOTOCATALYTIC OXIDATION SYSTEM

BACKGROUND OF THE INVENTION

[0001] The present invention relates generally to fluid purification systems and more particularly to ultraviolet photocatalytic oxidation systems.

[0002] Some air-handling systems include ultraviolet photocatalytic oxidation systems. A substrate coated with a photocatalyst, such as TiO2, is positioned in the fluid stream. Ultraviolet light is directed onto the photocatalyst to produce an oxidation process that removes many gases and chemicals, such as volatile organic compounds, from the air. However, ultraviolet lights are expensive and must be replaced periodically. There is also a pressure drop across the substrate, which is positioned in the fluid stream.

[0003] It has been proposed to use light-emitting diodes to generate ultraviolet light which is then directed onto a photocatalyst to maintain a photocatalytic oxidation process. In one proposed design for a muddler, a commercially-available LED is spaced away from one axial end of an elongated glass rod. The outer surface of the glass rod (other than the one axial end) is coated with a photocatalyst.

SUMMARY OF THE INVENTION

[0004] The present invention provides an LED ultraviolet photocatalytic oxidation device in a fluid handling system, such as an air handling system. In one embodiment of the present invention, the photocatalyst is disposed on a protective layer (e.g. glass or quartz) on the semiconductor of the LED. In another embodiment, the photocatalyst is disposed on the protective layer, which is separated from the

semiconductor by a fluid that filters or changes the wavelengths emitted by the LED. In a third embodiment, the photocatalyst is disposed directly on the semiconductor of the LED.

[0005] Coating the light-emitting diodes with the photocatalyst material combines the functions of the light source and the substrate. This improves the size, weight, pressure drop and maintenance of the photocatalytic system.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] Other advantages of the present invention can be understood by reference to the following detailed description when considered in connection with the accompanying drawings wherein:

[0007] Figure 1 is a cross-section of a photocatalytic oxidation device according to a first embodiment of the present invention.

[0008] Figure 2 is a cross-section of a photocatalytic oxidation device according to a second embodiment of the present invention.

[0009] Figure 3 is a cross-section of a photocatalytic oxidation device according to a third embodiment of the present invention.

[0010] Figure 4 is a perspective view of an array of photocatalytic oxidation devices of any of Figures 1-3.

[0011] Figure 5 is a perspective view showing the array of Figure 4 installed in an air handling system.

[0012] Figure 6 is a perspective view showing two arrays like the array of Figure 4 installed in an air handling system.

[0013] Figure 7 is a schematic side sectional view showing the operation of the arrangement of arrays in Figure 6.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Figure 1 is a sectional view of a photocatalytic oxidation device 20a according to a first embodiment of the present invention. A semiconductor 22, such as Si, GaAs, or other suitable material, is doped to create one or more light-emitting diodes 24 in a conventional manner. As is known, the light-emitting diodes 24 generate ultraviolet light when a potential difference is applied across them.

[0015] A protective layer 26 covers the semiconductor 22 and light-emitting diodes 24. The protective layer 26 may be glass, plastic, quartz or any other material used to protect the semiconductor 22 while transmitting the ultraviolet light produced by the light-emitting diodes 24.

[0016] A photocatalyst 28 is disposed on an outer surface of the protective layer 26. The photocatalyst 28 may be TiO2, or any other known photocatalyst that removes gases and chemicals, such as volatile organic compounds, from the air.

[0017] Figure 2 illustrates a second embodiment of the photocatalytic oxidation device 20b. In this embodiment, a fluid 32, such as a gas, is disposed between the light-emitting diodes 24 and the protective layer 26. The fluid 32 filters unwanted wavelengths or changes the wavelengths of the light emitted from the light-emitting diodes 24 so that the ultraviolet light that impacts the photocatlyst 28 contains the wavelengths necessary for photocatalytic oxidation.

[0018] A third embodiment of the photocatalytic oxidation device 20c is shown in Figure 3. In this device 20c, the photocatalyst 28 is disposed directly on the outer surface of the semiconductor 22 and the light-emitting diodes 24.

[0019] As shown in Figure 4, a plurality of photocatalytic oxidation devices 20 (the reference numeral "20" refers to any of the embodiments of the device 20a, b and c) are arranged in an array 36. The array 36 can be any size or shape, depending upon the particular application.

[0020] One possible application of the photocatalytic oxidation device array 36 is shown schematically in Figure 5. In Figure 5, the array 36 is installed in an air handling system 40 for a home, building or vehicle. The air handling system 40 includes a housing or plenum 42 defining an air stream therein and a fan 44 for moving air through the plenum 42.

[0021] In operation, air passing through the plenum 42 contacts the outer surface of the photocatalytic array 36. Ultraviolet light from the light-emitting diodes 24 produces photocatalytic oxidation on the surface of the photocatalyst 28. The oxidation removes many gases and chemicals, such as volatile organic compounds, from the air. The light-emitting diodes 24 (Figures 1-3) in the photocatalytic device array 36 last much longer than conventional ultraviolet light sources, thereby significantly reducing maintenance on the photocatalytic device array 36.

[0022] As shown in Figure 6, an air handling system 40a could include at least two facing arrays 36 on opposite walls of the plenum 42. The air handling system 40a could also include facing arrays 36 (not shown) on the other pair of opposing walls of the plenum 42.

[0023] Figure 7 illustrates the operation of the arrangement of arrays 36 in Figure 6. The thickness of the photocatalyst 28 on each of the arrays 36 is selected so that some of the ultraviolet light passes outwardly through the photocatalyst 28 on each array 36 and through the air onto the outer surface of the photocatalyst on the facing array 36.

This arrangement provides an efficient use of the ultraviolet light from the LEDs 24. In the arrangement shown in Figures 6 and 7, the light sources could be standard ultraviolet light sources, but are preferably the LEDs described above. Preferably the arrays 36 are the arrays 36 described above with respect to Figure 4, which in turn preferably each comprise the photocatalytic oxidation devices 20a-c, of Figures 1-3.

[0024] In accordance with the provisions of the patent statutes and jurisprudence, exemplary configurations described above are considered to represent a preferred embodiment of the invention. However, it should be noted that the invention can be practiced otherwise than as specifically illustrated and described without departing from its spirit or scope.